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Review of "Embryology, Epigenesis, and Evolution" and "Philosophy of Experimental Biology"

David Boersema
Pacific University

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Book Review

Embryology, Epigenesis, and Evolution. Jason Scott Robert. Cambridge University Press, 2004. 158 pages. Hardcover $60. ISBN 0-521-82467-2.

Philosophy of Experimental Biology. Marcel Weber. Cambridge University Press, 2005. 358 pages. Hardcover $75. ISBN 0-521-82945-3.

The latest volumes in the Cambridge Studies in Philosophy and Biology series, these two books represent the new generation of philosophers of biology. This new generation has shifted the foci of philosophical concerns from the "traditional" topics of e.g., units of selection, the nature of species, adaptationism, to sustainability, biological complexity, developmental biology, and biodiviersity, among others. This shift is perhaps better characterized less as a shift and more as an expansion of philosophical interest beyond just (or primarily) those of evolutionary biology and genetics. By no means an abandonment of concerns regarding evolutionary biology (or an indication that the "traditional" topics have been happily resolved), this shift in focus speaks to the fuller awareness and appreciation of biological matters other than evolutionary theory and their philosophical significance.

Jason Scott Robert's *Embryology, Epigenesis, and Evolution* is subtitled "Taking Development Seriously." Rejecting what he sees as the mistaken view of many philosophers of biology (and of too many biologists) that biological development is simply, or even primarily, a matter of gene activation and regulation, Robert claims that the processes and mechanisms of differentiation, morphogenesis, and growth both reveal and illuminate important philosophical issues. The first chapter ("The Problem of Development") details the central problem of development: how it is that a relatively simple, homogeneous cellular mass can become a relatively complex, heterogeneous organism. Robert acknowledges a deep connection between this central problem and modern molecular genetics, but denies that the latter provides a thorough explanation of the former. As he puts it, "The trick is to integrate [genetic] explanations with other developmental (cellular, environmental, and ecological) explanations within a larger organismal framework, rather than to assume that we understand development because we are beginning to grasp gene function" (p. 22). Chapter Two ("Exemplars") provides three case studies that he uses to focus discussion throughout the remainder of the book. This is followed in the next two chapters ("Scylla and Charybdis" and "Constitutive Epigenetics") by a tracing out of two historical strands in the history of biology, as well as the metaphors that have grown out of those strands and influence current thinking regarding development. The two strands are preformationism (something preformed develops into a mature organism) and epigenesis (guided/caused by some directing principle, a mature organism emerges from some simpler homogeneity over time; the organism is formed during ontogenesis rather than pre-existing it). Robert traces these two strands from Hippocrates and Aristotle up

through the 20th century. More important philosophically, Robert looks at the related metaphors, especially of late, that have played a role in the debate between these two strands, metaphors such as "information," "programme," and "triggering." For example, he points out at least two accounts of information, which are not always distinguished from each other: causal accounts and intentional accounts. Experimental results indicate that information is the causal sense is found in a wide range of sources, not only in or with genes. Likewise, information in the intentional sense (of being about something) has been shown also not to be gene-privileged. Quite simply, he says, "no coherent account of biological information has yet emerged that would justify the usual position that genes are uniquely informational" (p. 56). The view of genetic primacy should be replaced, for Robert, by one of "constitutive epigenetics": epigenetic events are developmental interactions within the whole-cell organism in its developmental context. Many epigenetic structures, he claims, are not stable and do not pre-exist the interaction, but rather emerge from these interactions in ontogenetic space and time. Chapter Five ("Creative Development") fleshes out this notion of constitutive epigenetics.

The final two chapters ("A New Synthesis?" and "The Devil is in the Gestalt") focus on the relationship between developmental biology and evolutionary theory, a position now commonly referred to as evolutionary developmental biology, or evo-devo. Arguing that evo-devo is a true synthesis, not a subsuming of development to evolution or vice versa, Robert uses several case studies to identify two fundamental relations between development and evolution: (1) most evolutionary changes are introduced during ontogeny and (2) developmental mechanisms themselves evolve. This genuine synthesis, rather than a subsuming, is what Robert considers taking development seriously, rather than development being something to explain away. "How we understand both heredity and evolution depends crucially on how we understand development" (p. 109). At least in part, then, development is an explanans, not an explanandum.

Where Robert's book is a detailed analysis of one area in biology (development), Weber's book is an analysis of various standard topics in the philosophy of science generally with respect to their relation to biological epistemology (i.e., experimental biology). In the book's initial footnote, Weber remarks that an anonymous reader for Cambridge University Press suggested that the work is not a study in the philosophy of biology, but in the philosophy of science as applied to biology. That's right. Each of the book's nine chapters focus not on standard philosophy of biology topics (again, such as units of selection or adaptationism) but on standard philosophy of science topics, such as reductionism, hypothesis testing, reference and conceptual change, and realism. The emphasis, of course, is on how these relate to biology, particularly biological practice and experiments. As Weber puts it, the book looks at ways in which scientific knowledge is structured, how it explains natural phenomena, how it is generated and evaluated, and how it connects to the world. Throughout the work, Weber relies on experimental cases from various branches of biology (e.g., neurobiology, biochemistry, microbiology).

The initial chapter is a detailed introduction to and summary of the remaining chapters. Chapter Two ("Reductionism and the Nature of Explanations") examines reductionistic explanations and argues for legitimate explanatory reduction of biology to chemistry and physics, at least for parts of biology, such as neurobiology. Included is the claim that functional explanations, at least ones not framed in etiological terms, are consistent with the reduction that Weber embraces.

Chapter Three ("Discovery: Solving Biological Problems") highlights the well-known Krebs cycle experiments as a departure point for discussing arguments concerning scientific discovery, in particular the search for a logic of discovery (or generative reasoning). Following an analysis and critique of two

models of generative reasoning, proposed by Ken Schaffner and Lindley Darden, Weber concludes that a common dynamic pattern of discovery can be identified, nevertheless, the most efficient problem-solving heuristics are domain specific, and, hence, not promising for a grander version of a logic of discovery. The next chapter ("Scientific Inference: Testing Hypotheses") continues the emphasis on scientific processes, though here focusing on traditional questions of underdetermination and Bayesian analysis of confirmation and evidence. Drawing especially on the work of Deborah Mayo, Weber demonstrates from detailed work in biochemistry that control of errors is the primary concern in theory (and hypothesis) testing, but not error in a formal, statistical sense.

Chapter Five ("Experimental Systems: A Life of Their Own?") captures, in miniature, the main thrust of the entire book, a move away from theory-dominated philosophy of science to an approach that stresses the study of experimental practice and laboratory settings. If science really is, as many scientists themselves claim, more about appropriate methods and techniques of producing and evaluating reliable data then about the actual results of those methods and techniques, then philosophy of science, to be intellectually responsible, needs to focus on "science as practice" more than "science as theory (or product)." Chapter Six ("Model Organisms: Of Flies and Elephants") continues this emphasis on actual laboratory practice by enunciating historical and contextual reasons why certain biological exemplars (e.g., Thomas Morgan's fruit flies) became the currency of experimentation.

Chapter Seven ("Reference and Conceptual Change: Out of Mendel's Garden?") is a straightforward look at the traditional issue of meaning change and reference change across time and theories. Focusing on how the concept of a gene was understood and used across the century and a half since Mendel, Weber argues that Philip Kitcher's notion of reference potential (as opposed to, say, Kripke's causal account) best captures the historically "floating reference" of the term "gene."

Chapter Eight ("Developmental Biology and the Genetic Program: Explaining Ontology") contains Weber's analysis of the material that Robert spends his book on, namely challenges to the geneticist program by developmental systems theory, along with discussion of the notion of biological information. Here Weber especially the notion of causality, or causal parity, in his critique of both the geneticists and the developmental systems theorists. Finally, Chapter Nine ("Scientific Realism: In Search of the Truth") addresses the old saw of realism and antirealism. He wrestles with some of the standard issues (e.g., if realism is false, scientific progress would be a miracle; theory realism vs. entity realism) and comes down to the conclusion that biologists rest their ontological beliefs in the reliability of the experimental procedures used.

What do these two books tell us? Several decades ago, Paul Feyerabend complained of the "creeps and incompetents" writing philosophy of science, by which he meant philosophers who had relatively little scientific expertise yet made proclamations on the nature and value of science. This complaint clearly does not apply to either of these authors. As noted above, they are representative of a new emphasis in philosophy of science on experiment, as opposed to theory or concepts, as the staring point of philosophical analysis. They also are representative of a new emphasis in philosophy of biology on topics other than, exclusively, evolution and molecular genetics. Robert's is the more sustained volume, truly a monograph, while Weber's is a confederation of essays relating biological experimentalism to topics in philosophy of science broadly speaking. Both are substantive and detailed. Both are fecund and timely. They speak well of the excellent reputation enjoyed by the Cambridge series on philosophy and biology. Their audience really is for philosophers of science and philosophers of biology only, as the treatment of

even those topics that relate to other areas of philosophy (e.g., reference) is minimally enhanced by these works. Nonetheless, they are very fruitful works in their fields and should receive a large audience.

David Boersema
Pacific University